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# FOOD HABITS OF BLACK DUCKS WINTERING IN WEST CENTRAL TENNESSEE

Progress Report 1990-91
Submitted as an M.S. thesis
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# IN WEST CENTRAL TENNESSEE

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A Thesis

Presented to

the Faculty of the Graduate School

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by

Veronica E. Byrd

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In Partial Fulfillment

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AN ABSTRACT OF A THESIS

# FOOD HABITS OF BLACK DUCK WINTERING IN WEST CENTRAL TENNESSEE

Veronica E. Byrd

Master of Science in Biology

This study was conducted to describe the food habits of black ducks (*Anas rubripes*) wintering in west central Tennessee and to compare foods of black ducks and mallards (*A. platyrhynchos*) collected from sympatric habitats. Ducks were collected from Tennessee National Wildlife Refuge (TNWR) during winter 1990-91. Seeds predominated in the diet of black ducks and mallards; with spikerush (*Eleocharis* sp.), smartweed (*Polygonum hydropiperoides*), rice cutgrass (*Leersia oryzoides*), and buttonbush (*Cephalanthus occidentalis*) being the most common. Seasonal variation and differences in diets between black ducks and mallards were best explained by differences in habitat selection and food availability. Despite minor differences in food habits between black ducks and mallards at TNWR, food habits of the species were similar. No significant differences were detected between diets of males or females wintering at TNWR. Black ducks fed primarily upon low protein foods, perhaps indicating that energy requirements for maintenance and spring migration were more important than protein demands. Foods high in carbohydrates and fats were primary foods consumed by black ducks and mallards, and energy appears to be the primary dietary need of black ducks wintering at TNWR.

## ACKNOWLEDGEMENTS

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CHAPTER 1

# Introduction

American black duck (*Anas rubripes*) populations have declined in recent years throughout the United States (Barske 1968, Grandy 1983). These declines probably have been influenced by a number of factors, including hunting mortality (Grandy 1983, Krementz et al. 1988, Rusch et al. 1988), non-hunting mortality (Bennett et al. 1975, Ringleman and Longcore 1983, Rusch et al. 1988, Conroy et al. 1989), habitat loss and modifications (Johnsgard 1961, Heusmann 1974), and hybridization and/or competition with mallards (*A. platyrhynchos*) (Goodwin 1956, Johnsgard 1967, Ankney et al. 1987).

Winter is a critical time for black ducks (Reinecke et al. 1982), during which they must consume energetically rich foods to offset costs of thermoregulation and other energy demanding processes (Longcore and Gibbs 1988). Reduced food availability and low temperatures during winter influence body condition and survival of waterfowl (Grome 1936, Hagar 1950). As available foods decline during winter, population mortality increases, and breeding potential for the following summer possibly declines (Prince 1979). Owen and Cook (1977) found correlations between body condition of mallards wintering in England and the amount of cereal grain available on stubble fields, and they suggested that these relationships influence winter survival and subsequent reproduction.

Reinecke et al. (1982) demonstrated that immature female black ducks achieved adult structural size during winter, but juveniles were lighter in weight and had smaller nutrient reserves than did adult females. Other studies have corroborated relationships between age, body condition (as influenced by food availability), and probability of winter survival. Hepp et al. (1986) reported that mallards in poor condition (based upon weight/wing length) were more likely to be shot by hunters than those in better condition. Haramis et al. (1986) reported a direct relationship between body mass of canvasbacks (Aythya valisineria) in early winter and the probability of surviving the winter. Immature black ducks are more vulnerable to hunting and have lower annual survival rates than do adults (Krementz et al. 1987, 1988; Conroy et al. 1989). Winter food availability, thus, influences winter survival because food availability is the primary factor influencing body condition (Grome 1936, Hagar 1950, Haramis et al. 1986).

Black duck courtship behavior also is influenced by food on wintering habitats (Brodsky and Weatherhead 1985). Animals must satisfy their maintenance requirements before allocating time and energy to breeding activity (King 1974), and black ducks with reduced food availability breed later than ducks with readily available foods (Brodsky and

Weatherhead 1985). Differences in foods available to wintering black ducks may influence their reproductive fitness without affecting individual survival (Brodsky and Weatherhead 1985), and ducks from energy-rich sites may be better prepared to breed in summer than ducks from poorer sites.

Waterfowl change feeding strategies and food types to meet seasonally changing nutritional and energy requirements (Swanson et al. 1979). Waterfowl shift from unstable freshwater habitats during the breeding season to more stable, permanent wetlands or marine environments in winter (Fredrickson and Drobney 1979). On wintering areas, waterfowl also shift from feeding at higher trophic levels to lower trophic levels (Weller 1975). Percentage of time spent feeding by waterfowl is highest in fall, declines in winter, and increases in early spring (Paulus 1988). Seasonal trends in time budgets of nonbreeding waterfowl are closely related to food availability and diet quality and to energy stored as fat to be used later in winter (Paulus 1983, Miller 1985). Molting waterfowl may increase foraging rates in autumn to acquire specific nutrients for feather formation (Quinlan and Baldassarre 1984). By early winter, climatic conditions on many wintering areas are moderate; and most ducks have acquired large fat reserves and have completed the prealternate molt. Consequently, less energy intake is required than in autumn (Tamisier 1974). By late winter, time spent feeding increases because of food scarcity, colder temperatures, and preparation for spring migration (Tamisier 1974, Miller 1985). Energy intake and time spent feeding also may be elevated to meet nutrient needs for upcoming egg-laying and breeding activities (Paulus 1984, Heitmeyer 1988).

Most species of dabbling ducks (i.e., tribe Anatini) consume primarily different foods from other species even while sharing the same habitats, but some overlap in food habits exists during fall and winter (Miller 1984, Korschgen 1955). Black ducks and mallards are closely related phylogenetically and are sympatric over much of their range (Bellrose 1976). Black ducks and mallards consume a diversity of plant and animal foods, but the amount of overlap in food habits between these species is not well documented.

Many studies have indicated that plant material is the major food item of wintering mallards (Dillon 1959, Jorde et al. 1983, Delnicki and Reinecke 1986, Allen 1980, Hirst and Easthope 1984, Korschgen 1955, Combs 1987, Forsyth 1965, Wright 1961). Although invertebrate consumption by wintering mallards has been widely documented, animal foods generally constitute a small percentage of the diet and have been considered major components in only a few studies (White 1982, Heitmeyer 1985).

Only a few black duck food habit studies have been conducted, and these have primarily consisted of samples taken from coastal wetlands and marine environments (Addy

1945, Mendall 1945, Hagar 1950, Siegler 1950, Coulter 1955, Hartman 1963, Cronan and Halla 1968, Kerwin and Webb 1971). Invertebrates, especially mollusks, have comprised the dominant item in most coastal samples; and a measurement of saltwater clam densities has been incorporated as a variable in the Habitat Suitability Model of black ducks wintering in such habitats (Lewis and Garrison 1984). A small sample of black ducks (n=9) from an inland population in Missouri was found to feed primarily upon plant material and contained only 4.3% animal material (Korschgen 1955). Food habit studies from other inland populations of black ducks are lacking.

Food habit studies are necessary before effective management programs can be initiated (Mendall 1949), but such a study is lacking for black ducks in west central Tennessee. The goal of this research was to determine primary foods of black ducks wintering at Tennessee National Wildlife Refuge (TNWR). Although average numbers of black ducks using TNWR during 1990-91 were low (i.e., 4,000), populations during many winters have exceeded 25,000 (TNWR Waterfowl Inventory Records 1990); and yet food habits of black ducks on TNWR are not well understood. Specific objectives of this research were to determine food habits of wintering black ducks on TNWR and to compare foods of black ducks and mallards collected from sympatric habitats.

# CHAPTER 2

## Study Area Description

TNWR was chosen because of the large number of wintering black ducks (TNWR Waterfowl Inventory Records 1957-91) and lack of hunting pressure. TNWR was created in 1945 on Tennessee Valley Authority lands and consists of 20,788 ha. TNWR is comprised of 3 disjunct units located on land adjacent to the Tennessee River. Ducks for this study were collected on the Duck River Unit of TNWR. The Duck River Unit is composed of 8 moist-soil impoundments that support a variety of native plants; smartweed (Polygonum spp.) and spikerush (Eleocharis spp.) being the most common. Wildlife management practices on TNWR are mostly devoted to providing waterfowl habitat. Although agricultural crops often are grown as waterfowl food, natural foods greatly exceeded agricultural foods on the refuge during winter 1990-91.

Temperatures during winter 1990-91 were mild. Mean temperatures during November, December, January, and February were 12°C, 5.3°C, 6.4°C, and 5.5°C, respectively [National Oceanic and Atmospheric Administration (NOAA) 1990]. Maximum and minimum temperatures for November, December, January, and February were 19.2°C and 4.5°C, 11.6°C and 1.1°C, 11.8°C and 2.5°C, and 12°C and 0.8°C, respectively (NOAA 1990). December and February were the only months that had days where the temperature dropped to 0°C or below; December had two days and February had one (NOAA 1990). Total precipitation during November, December, January, and February was 7.06 cm, 35.73 cm, 13.74 cm, and 17.14 cm, respectively (NOAA 1990). December was the only month that recorded snow (i.e., 1.27 cm) (NOAA 1990).

# CHAPTER 3

## Materials and Methods

Black ducks were collected by shooting on TNWR from November 1990 to February 1991. Mallards were collected concurrently to compare food habits of the two species. Ducks were collected primarily from feeding flocks to increase the likelihood of foods being present in their digestive tracts.

Contents of the esophagus, proventriculus, and gizzard of ducks were removed immediately following collection and preserved in 70% ethanol to prevent postmortem digestion (Swanson and Bartonek 1970). Food samples were sorted and identified after soaking in distilled water for 24 hours to rehydrate foods. Plant foods were identified with botanical texts (i.e., Martin and Barkley 1961; Godfrey and Wooten 1979, 1981), and animal foods were identified with invertebrate texts (i.e., Pennak 1978, Merritt and Cummings 1984). Volume of each food item was measured by water displacement, and dry weight was measured after drying for 48 hours at 50°C. Volumes were measured to the nearest 0.01 ml and weights to the nearest 0.01 g. Volumes and weights less than 0.1 (ml or g) were listed as trace items. Data were analyzed by percent occurrence and by aggregate percent dry weight and volume (Swanson and Bartonek 1970). Samples with less than 0.01 g or less than 5 food items were not included in the analysis.

Mann-Whitney U-tests (Siegler 1956) were used to compare food habits of mallards and black ducks and food habits of male and female black ducks and mallards. Kruskal-Wallis analysis of variance (Siegel 1956) was used to compare monthly differences in food habits of black ducks and mallards. An alpha level of 0.10 was in all statistical tests.

# CHAPTER 4

## Results

Very little Ag crops were grown on refuge in 1990

The major component of the diet of wintering black ducks and mallards collected on TNWR during 1990-91 consisted of seeds of native marsh plants. Black ducks and mallards most commonly consumed spikerush, smartweed, rice cutgrass (<u>Leersia oryzoides</u>), and buttonbush (<u>Cephalanthus occidentalis</u>) seeds (Tables 1, 2; Figs. 1, 2). Spikerush and smartweed seeds were the 2 most abundant food items (i.e., aggregate percent volume and aggregate percent dry weight) in black duck samples (Fig. 3), whereas spikerush and Johnson grass (<u>Sorghum halepense</u>) seeds had similar importance to mallards (Fig. 4).

Mallards and black ducks consumed similar food items, but some differences were detected. Black ducks consumed more smartweed ($\underline{P}$=0.014) and vegetative parts (i.e., stems and leaves) ($\underline{P}$=0.057) than mallards, and mallards consumed more Johnson grass seeds ($\underline{P}$=0.03) and milo grain ($\underline{P}$=0.04) than black du du ducks. Although the percentage of animal material eaten by black ducks and mallards were similar, black ducks consumed more varied animal material (Fig. 5) than mallards (Fig. 6). No differences were detected between food habits of male and female black ducks or mallards.

Table 1. Esophageal and Proventricular Contents of Black Ducks (n=39) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

| Food item | % Occurrence | Aggregate % volume | Aggregate % dry weight |
|---|---|---|---|
| Plant Seeds | | | |
| Tooth cups *Ammania coccinea* | 2.6 | 0.6 | 0.3 |
| Bermuda grass *Cynodon dactylon* | 7.7 | 4.1 | 4.1 |
| Spikerush *Eleocharis* sp. | 84.6 | 42.3 | 40.8 |
| Smartweed *Polygonum hydropiperoides* | 64.1 | 18.8 | 17.9 |
| Buttonbush *Cephalanthus occidentalis* | 33.3 | 0.1 | 1.9 |
| Rice cutgrass *Leersia oryzoides* | 51.3 | 4.2 | 4.3 |
| Sticktight *Bidens cernua* | 12.8 | 0.1 | 0.7 |
| Beggar's tick *Bidens vulgata* | 10.3 | tr[a] | 0.6 |
| Tickleseed *Coreopsis tripteris* | 2.6 | tr | 0.5 |
| Sumpweed *Iva frutescens* | 2.6 | 0.2 | 0.4 |
| Millet *Echinochloa crusgalli* | 10.3 | 0.2 | 0.5 |
| Subtotal | 93.4 | 70.6 | 72.0 |

Table 1 (continued).

| Food item | % Occurrence | Aggregate % volume | Aggregate % dry weight |
|---|---|---|---|
| Grain | | | |
| Sorghum/Milo *Sorghum vulgare* | 2.6 | tr | 0.2 |
| Corn *Zea mays* | 10.3 | 4.7 | 4.6 |
| Wheat *Triticum aestivum* | 5.1 | 1.2 | 0.4 |
| Subtotal | 24.5 | 5.9 | 5.2 |
| Vegetation | | | |
| Tubers | 5.1 | 3.2 | 2.8 |
| Roots | 20.8 | 1.1 | 1.1 |
| Herbaceous stems | 48.7 | 10.9 | 11.3 |
| Woody stems | 5.1 | 4.3 | 1.8 |
| Subtotal | 57.1 | 19.5 | 17.0 |
| Animal Material | | | |
| Snail *Helisoma* sp. | 7.7 | 0.2 | 0.5 |
| Fairy egg case *Caraphractus cinctus* | 5.1 | 0.8 | 0.1 |
| Perwinkle *Lymanea* | 18.0 | 0.2 | 0.8 |
| Dragonfly (lr)[b] *Libellula* | 2.6 | 0.4 | 0.2 |
| Soldier fly (lr) *Odonotomyia* sp. | 12.8 | 0.2 | 0.5 |
| Water scavenger beetle *Berosus* sp. | 5.1 | 0.1 | 0.1 |

Table 1 (continued).

| Food item | % Occurrence | Aggregate % volume | Aggregate % dry weight |
|---|---|---|---|
| Biting midge (lr) <u>Artrichopogon</u> sp. | 25.6 | 0.8 | 1.5 |
| Soldier fly (lr) F. Stratiomyidae | 2.6 | tr | tr |
| Water boatman F. Corixidae | 10.3 | tr | 0.8 |
| Crane fly (lr) F. Tipulidae | 2.6 | 0.1 | 0.1 |
| Diving Beetle (lr) F. Dytiscidae | 2.6 | tr | tr |
| Water scavenger beetle F. Hydrophilidae | 7.7 | tr | 0.4 |
| Clams F. Sphaeridae | 2.6 | 0.2 | 0.4 |
| Dragonfly (lr) F. Gomphidae | 2.6 | 0.9 | 0.3 |
| Biting midge (lr) F. Ceratopognidae | 7.7 | tr | 0.1 |
| Subtotal | 43.6 | 3.9 | 5.8 |

[a] tr = trace.
[b] (lr) = larvae.

Table 2. Esophageal and Proventricular Contents of Mallards (n=24) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

| Food item | % Occurrence | Aggregate % volume | Aggregate % dry weight |
|---|---|---|---|
| Plant seeds | | | |
| Johnson grass *Sorgum halepense* | 33.3 | 27.4 | 29.3 |
| Spikerush *Eleocharis* sp. | 62.5 | 42.4 | 40.6 |
| Sticktight *Bidens cernua* | 8.3 | tr[a] | 0.1 |
| Buttonbush *Cephalanthus occidentalis* | 20.8 | 0.1 | 0.2 |
| Smartweed *Polygonum hydropiperoides* | 37.5 | 4.9 | 5.5 |
| Rice cutgrass *Leersia oryzoides* | 41.6 | 0.1 | 1.9 |
| Sumpweed *Iva frutescens* | 4.2 | 0.9 | 0.8 |
| Bermuda grass *Cynodon dactylon* | 4.2 | tr | 0.1 |
| Sida *Sida spinosa* | 4.2 | 0.1 | 0.1 |
| Millet *Echinochloa crusgalli* | 12.5 | 7.8 | 8.7 |
| Subtotal | 100.0 | 83.6 | 87.2 |
| Grain | | | |
| Sorghum/Milo *Sorgum vulgare* | 33.3 | 5.4 | 3.4 |
| Subtotal | 33.3 | 5.4 | 3.4 |

Table 2 (continued).

| Food item | % Occurrence | Aggregate % volume | Aggregate % dry weight |
|---|---|---|---|
| Vegetation | | | |
| Tubers | 8.3 | 0.4 | 0.3 |
| Herbaceous vegetation | 12.5 | 8.4 | 4.3 |
| Roots | 4.2 | 0.1 | 0.1 |
| Subtotal | 37.5 | 8.9 | 4.7 |
| Animal Material | | | |
| Soldier fly (lr)[b] *Odonotomyia* sp. | 29.2 | 0.3 | 0.7 |
| Perwinkle *Lymanea* sp. | 12.5 | 0.4 | 1.6 |
| Water scavenger beetle (lr) *Berosus* sp. | 4.2 | tr | 0.4 |
| Biting midge (lr) *Artichopogon* sp. | 8.3 | 0.2 | 0.6 |
| Snail *Helisoma* sp. | 8.3 | 0.2 | 0.4 |
| Water boatman F. Corixidae | 12.5 | 0.3 | 0.3 |
| Earthworm Oligochaeta | 20.8 | 0.5 | 0.6 |
| Crane fly (lr) F. Tipulidae | 4.2 | 0.1 | 0.1 |
| Subtotal | 62.5 | 2.1 | 4.6 |

[a] tr = trace.
[b] (lr) = larvae.

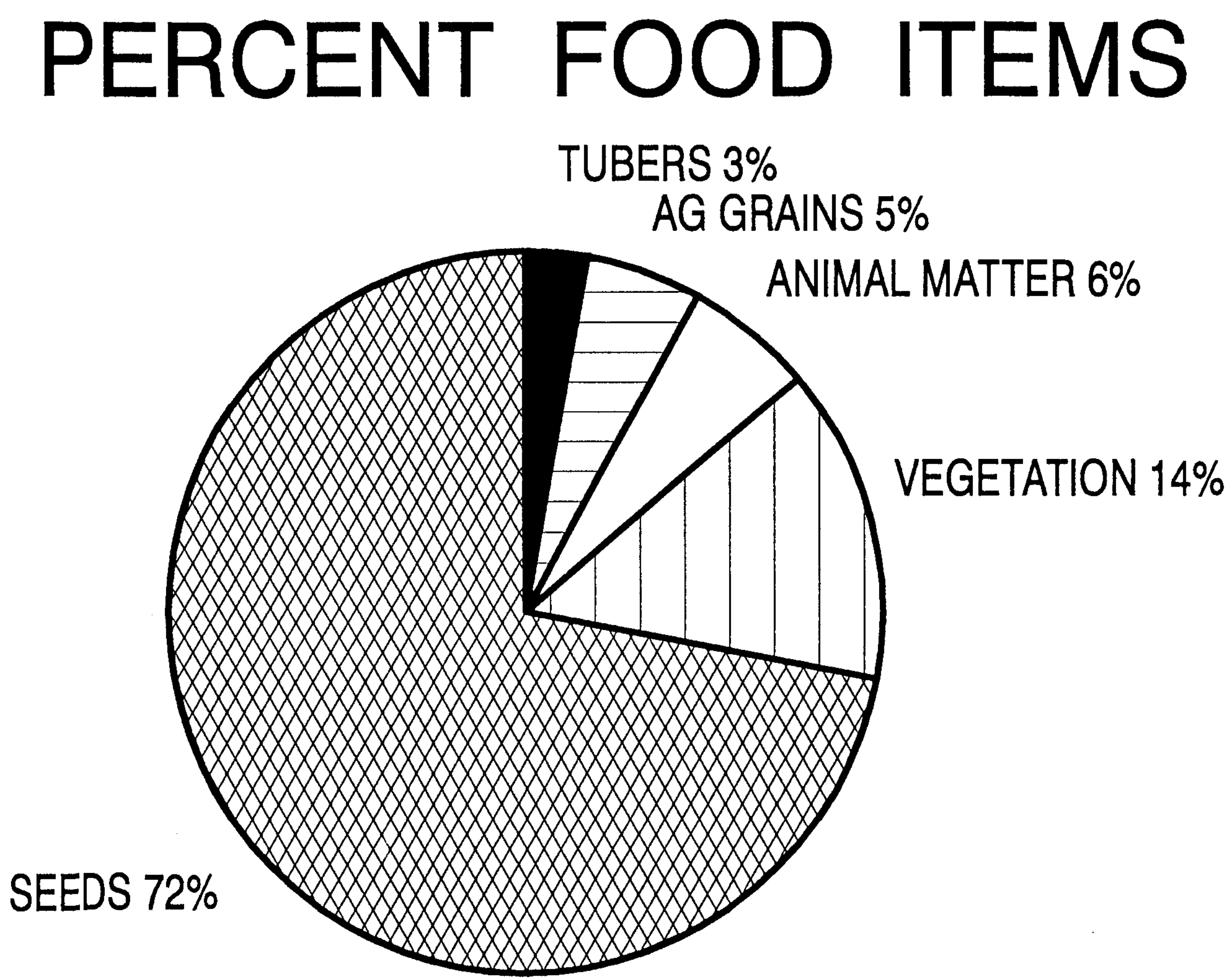


Figure 1. Aggregate Percent Dry Weight of Major Food Groups in Esophageal and Proventricular Samples from Black Ducks (n=39) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

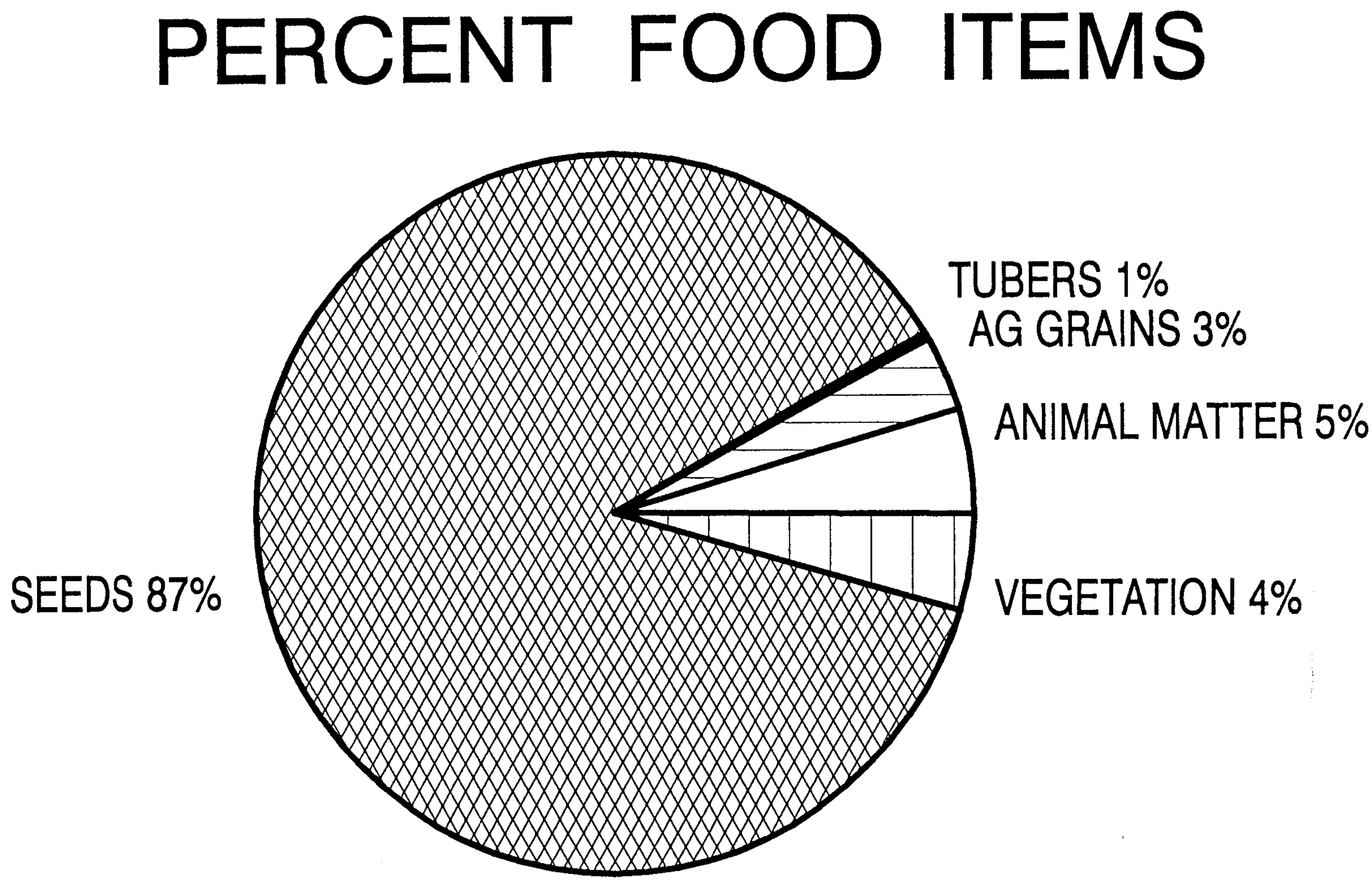


Figure 2. Aggregate Percent Dry Weight of Major Food Groups in Esophageal and Proventricular Samples from Mallards (n=24) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

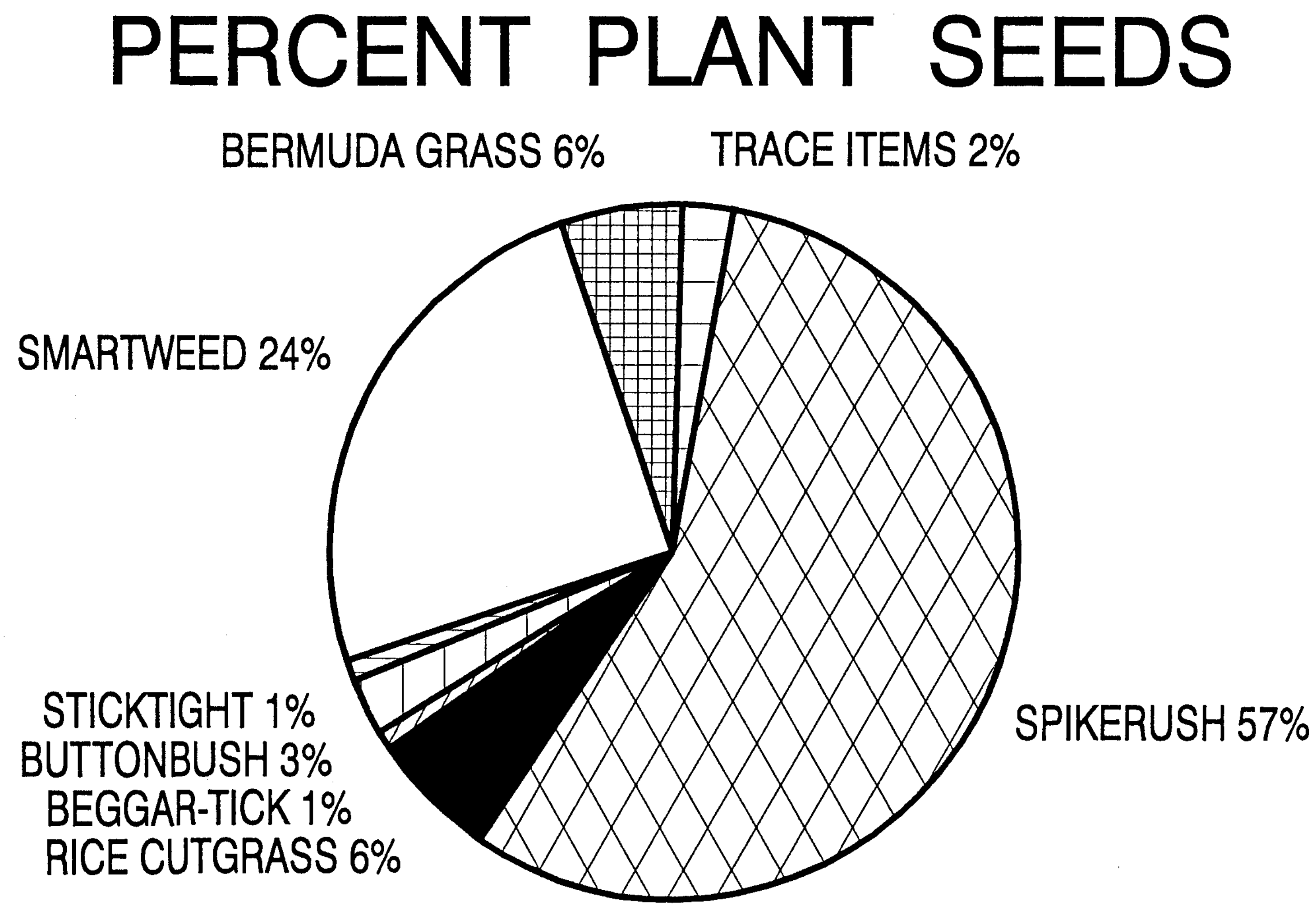


Figure 3. Aggregate Percent Dry Weight of Seed Items in Esophageal and Proventricular Samples from Black Ducks (n=39) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

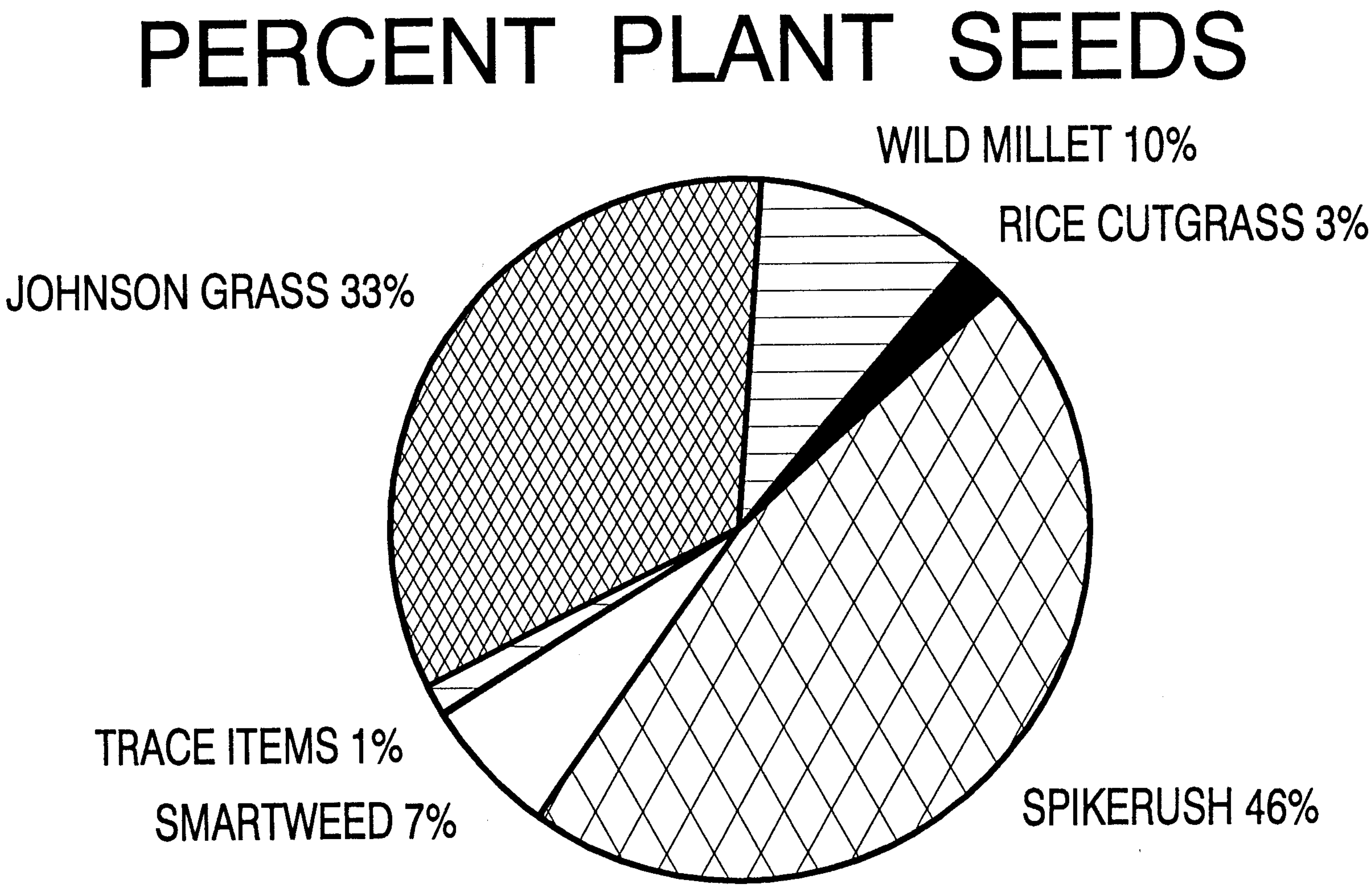


Figure 4. Aggregate Percent Dry Weight of Seed Items in Esophageal and Proventricular Samples from Mallards (n=24) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

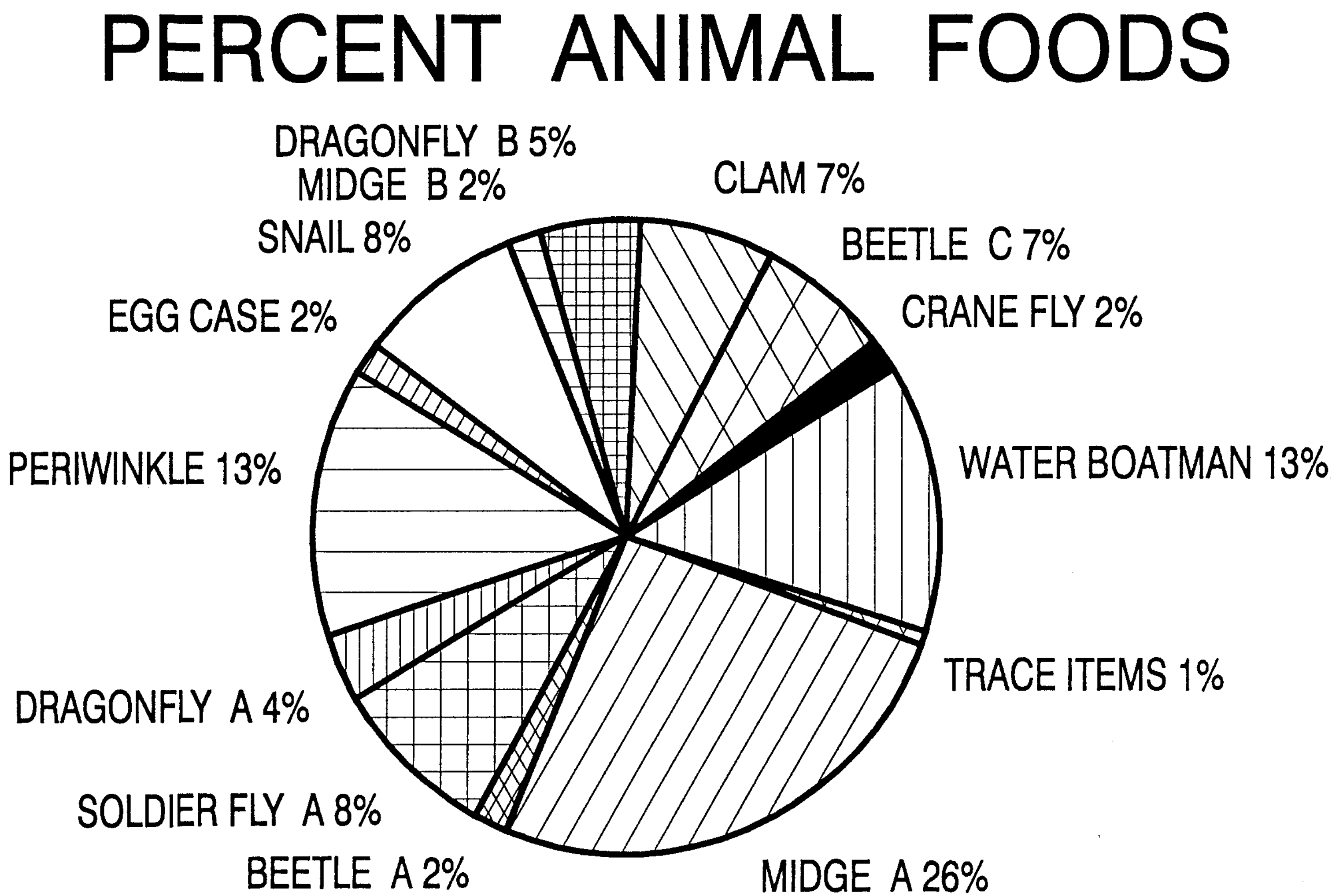


Figure 5. Aggregate Percent Dry Weight of Animal Items in Esophageal and Proventricular Samples from Black Ducks (n=39) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

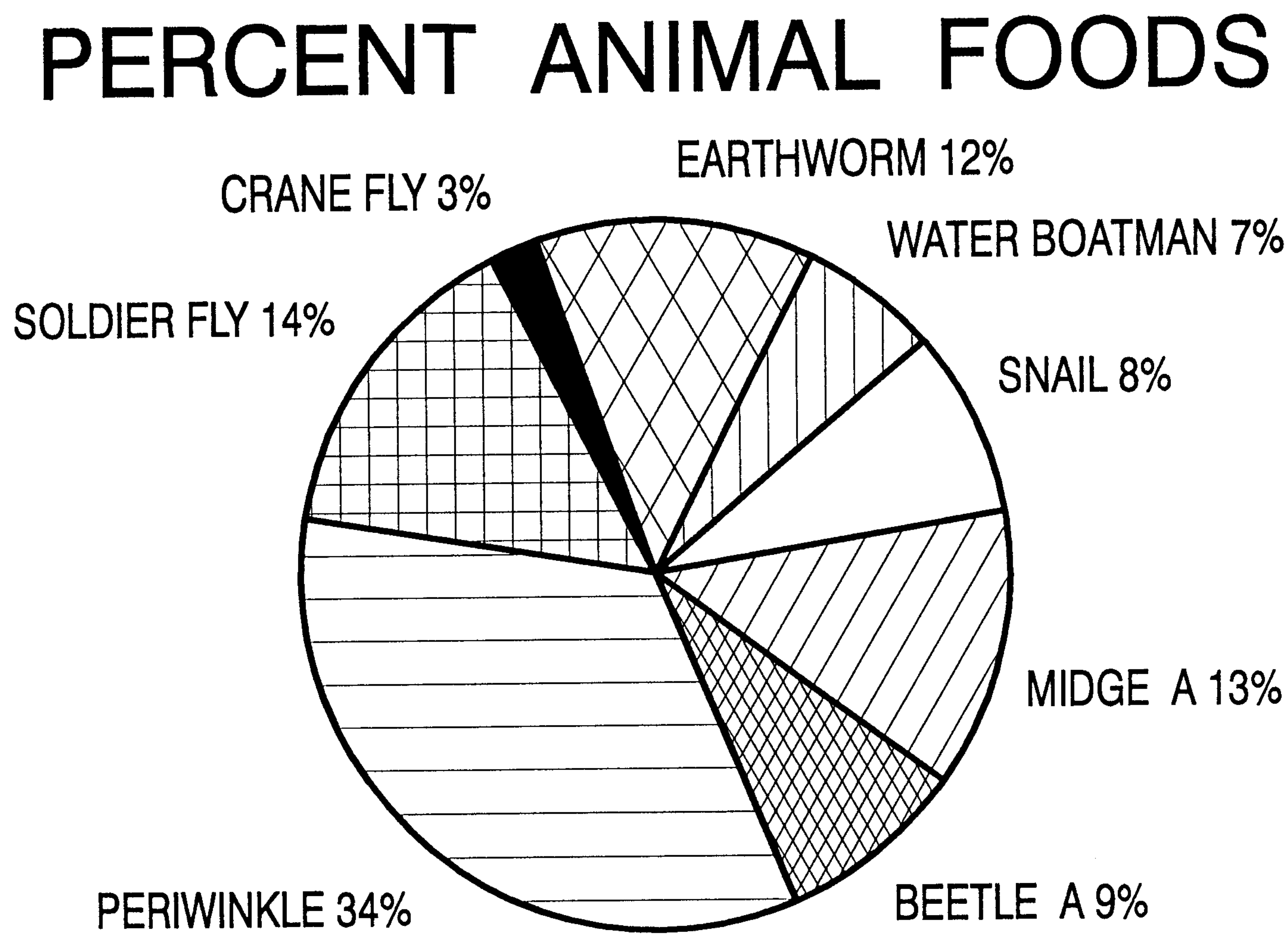


Figure 6. Aggregate Percent Dry Weight of Animal Items in Esophageal and Proventricular Samples from Mallards (n=24) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

Seasonal differences in food habits were detected for both black ducks and mallards. Percentage of animal material consumed by black ducks varied throughout winter (*P*<0.01), with highest consumption occurring during November and lowest during January (Fig. 7). Animal material consumption did not vary seasonally for mallards.

Although seasonal differences in total seed consumption was not detected for either species, some variation of specific plant consumption did occur. Spikerush was consumed in greatest quantities by black ducks during December and January (*P*=0.085). Agricultural grains occurred in greatest amounts in black duck samples collected during February and December (*P*=0.007), and no samples containing grain were collected during November.

Mallard consumption of seeds and agricultural foods declined throughout winter (*P*=0.006, *P*=0.054), as did spikerush and millet (*Echinochloa crusgalli*) consumption (*P*=0.021, *P*=0.035). Rice cutgrass consumption by mallards peaked during January (*P*=0.069), whereas Johnson grass and milo were consumed in greatest amounts during December (*P*=0.020, *P*=0.020). More vegetative parts were consumed by mallards during November than during any other months (*P*=0.045).

Due to choice or availability?

Four black duck/mallard hybrids were collected during this study, but the sample size was too small to statistically analyze. Spikerush and smartweed were the most abundant seeds in esophageal samples of hybrids, and

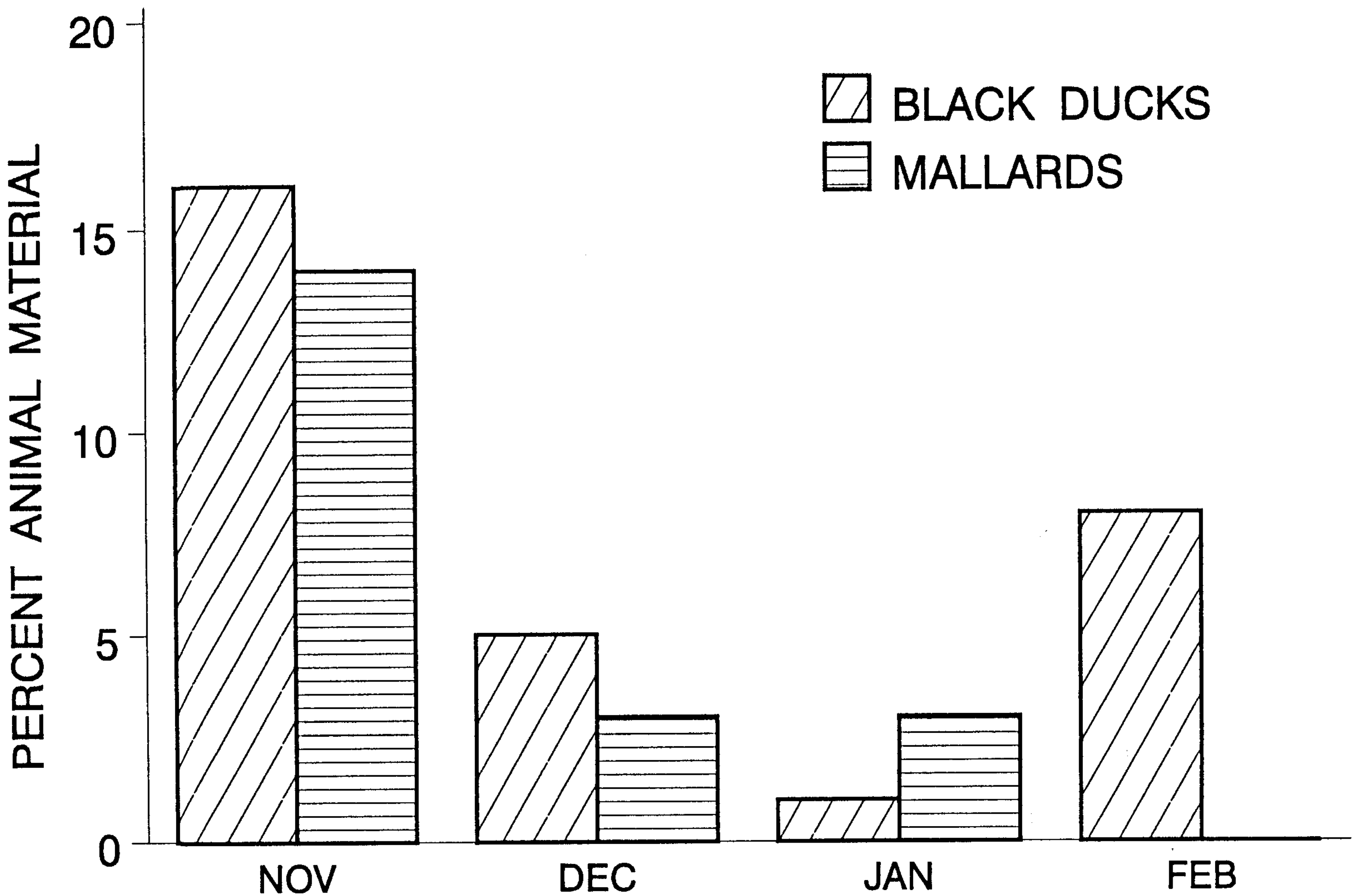


Figure 7. Seasonal Differences in Aggregate Percent Dry Weight of Animal Material in Esophageal and Proventricular Samples from Black Ducks (n=39) and Mallards (n=24) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

hybrids consumed more seeds and vegetative parts than animal foods (Table 3).

Major foods consumed by black ducks and mallards vary widely in chemical composition and nutrient quality (Table 4). There are six important categories used to assess food value: protein, energy, fat, crude fiber, ash, and nitrogen-free extract (NFE). Crude fiber is largely cellulose and unavailable to waterfowl because of low digestibility (Mattocks 1971), but NFE is comprised of sugars and starches and serves as the primary source of nonspecific energy for birds (Reinecke and Owen 1980). Ash represents the mineral content of food items.

Agricultural grains are low in protein, but high in carbohydrates (i.e., NFE). Tubers also contain many carbohydrates, but they are comprised of more protein than grain (Sugden 1973). Moist-soil seeds are highly variable but generally contain large amounts of protein and fiber and less carbohydrates than grain. Moist-soil seeds consumed in this study were high in carbohydrates (i.e., NFE), proteins and minerals (i.e., ash) (Table 4). Invertebrates are generally high in proteins and minerals but are lacking in carbohydrates (Sugden 1973, Reinecke and Owen 1980, Heitmeyer 1985, Miller 1987).

Table 3. Esophageal and Proventricular Contents of Black Duck / Mallard Hybrids (n=4) Collected from Tennessee National Wildlife Refuge during Winter 1990-91

| Food item | % Occurrence | Aggregate % volume | Aggregate % dry weight |
|---|---|---|---|
| Plant Seeds | | | |
| Smartweed *Polygonum hydropiperoides* | 75.0 | tr[a] | 6.1 |
| Spikerush *Eleocharis* sp. | 100.0 | 95.0 | 74.9 |
| Rice cutgrass *Leersia oryzoides* | 25.0 | 0.1 | 0.4 |
| Sticktight *Bidens cernua* | 25.0 | 0.1 | 0.4 |
| Tickleseed *Coreopsis tripteris* | 25.0 | tr | 0.1 |
| Buttonbush *Cephalanthus occidentalis* | 50.0 | tr | 2.6 |
| Pigweed *Amaranthus* sp. | 25.0 | tr | 0.1 |
| Beggar's tick *Bidens vulgata* | 25.0 | tr | 5.0 |
| Subtotal | 100.0 | 95.2 | 89.6 |
| Vegetation | | | |
| Herbaceous vegetation | 50.0 | 3.9 | 1.3 |
| Subtotal | 50.0 | 3.9 | 1.3 |
| Animal Material | | | |
| Snail *Helisoma* sp. | 25.0 | 0.3 | 0.5 |
| Biting midge (lr)[b] *Artichopogon* sp. | 50.0 | 0.1 | 7.7 |

Table 3 (continued).

| Food item | % Occurrence | Aggregate % volume | Aggregate % dry weight |
|---|---|---|---|
| Periwinkle *Lymanea* sp. | 50.0 | 0.2 | 0.5 |
| Soldier fly (lr) F. Stratiomyidae | 25.0 | tr | 0.1 |
| Dragonfly (lr) *Libellula* sp. | 25.0 | 0.3 | 0.3 |
| Subtotal | 100.0 | 0.9 | 9.1 |

[a] tr = trace.
[b] (lr) = larvae.

Table 4. Chemical Composition (% of Dry Weight) of Selected Food Items from Ducks Collected at Tennessee National Wildlife Refuge during Winter 1990-91

| Food Item | Energy (Kcal/Kg) | Percent Fat | Percent Fiber | Percent Protein | Percent Ash | Percent NFE | Source |
|---|---|---|---|---|---|---|---|
| Animal Material | | | | | | | |
| Lymanea | 0.92 | 0.7 | 12.4 | 16.9 | 64.2 | 5.8 | A[a] |
| Libellula | 5.109 | 8.2 | 11.1 | 66.7 | 5.6 | 8.4 | B |
| F. Corixidae | 5.109 | 5.0 | 18.4 | 71.1 | 4.7 | 0.8 | B |
| F. Dystiscidae | | | | 71.0 | | | C |
| F. Hydrophilidae | | | | 63.9 | | | C |
| Oligochaeta | | 7.7 | 0.4 | 60.2 | | 12.3 | D |
| Plant Seeds | | | | | | | |
| Rice cutgrass | 3.738 | 2.0 | 10.7 | 11.0 | 10.2 | | E |
| | | 1.9 | 9.3 | 13.8 | 7.6 | 57.8 | F |
| Smartweed | | 1.9 | 20.1 | 8.4 | 2.0 | 57.9 | F |
| Milo | | 2.5 | 11.2 | 9.9 | | 72.5 | G |
| | 4.4 | 3.1 | 2.2 | 11.9 | 2.7 | | H |
| Sida | 4.9 | | | | | | I |

Table 4 (continued).

| Food Item | Energy (Kcal/Kg) | Percent Fat | Percent Fiber | Percent Protein | Percent Ash | Percent NFE | Source |
|---|---|---|---|---|---|---|---|
| Wheat | 3.6 | 1.9 | 3.6 | 15.4 | 2.1 | | J |
| | 4.7 | | | | | | K |
| Beggar-tick | 4.517 | 10.8 | 21.0 | 16.875 | 15.6 | | E |
| Buttonbush | 6.7 | 46.9 | 8.9 | | | | C |
| | | 3.8 | | 5.6 | | | L |
| Spikerush | | 2.1 | 38.9 | 6.8 | 11.9 | 40.2 | M |
| Wild millet | | 0.5 | 31.3 | 14.2 | 7.3 | 46.6 | D |

[a] A = Sudgen 1973, B = Reinecke and Owen 1980, C = Drobney 1977, D = Krapu 1972, E = Knauer 1977, F = Landers et al. 1977, G = Korschgen 1980, H = Fredrickson and Taylor 1982, I = Kendeigh and West 1965, J = Sudgen 1971, K = Long 1934, L = Bonner 1974, M = Barnwell et al. 1962.

## CHAPTER 5

## Discussion

Plant foods normally predominate in the diet of black ducks wintering in fresh and brackish habitats, but black ducks in maritime habitats consume mostly animal foods (Palmer 1976, Lewis and Garrison 1984). South of Cape Cod, increasing amounts of plant material are found in the diets of wintering black ducks, but animal foods are consumed more readily farther north (Lewis and Garrison 1984). In coastal South Carolina, winter foods of black ducks were 98% plant material and only 1.6% animal material (Kerwin and Webb 1971). Animal foods probably predominate in the diet of black ducks in maritime habitats because of food availability and ice cover. During winter when ice and snow make plant foods inaccessible (Kirby and Ferrigno 1980), animal foods become especially important (Lewis and Garrison 1984). In maritime habitats, black ducks are usually restricted to feeding on mudflats and tidal areas where mollusks are abundant but plant foods scarce because these areas alone remain ice free. In tidal waters, animal foods are important because they are easily obtained and not necessarily because black ducks exhibit a particular fondness for them (Mendall 1949).

Seeds predominated in the diet of black ducks collected during this study. Feeding habitats of black ducks at TNWR were not restricted by ice cover, and plant seeds were abundant and readily available. Seeds also comprised the most important component of the winter diet of mallards at TNWR during 1990-91. Waterfowl are opportunistic and often use the most abundant foods available (Fredrickson and Drobney 1979). Differences between primary foods consumed by black ducks in maritime habitats and those of ducks collected during this study probably are a reflection of food availability.

Seasonal variability in food habits and differences in diets between black ducks and mallards are best explained by differences in habitat selection and food availability. Spikerush, smartweed, and Johnson grass were the predominant plants found in TNWR habitats (TNWR Plant Productivity Records 1990-91), and these were the most abundant foods in esophageal samples collected during this study. Black ducks consumed more smartweed and vegetative parts and less agricultural grains and Johnson grass than mallards probably because black ducks occurred more often along levees and less often in agricultural fields than mallards (T. White, pers. comm.).

Black ducks and mallards both consumed vegetative parts in greatest quantities during November probably because leaves and stems are available until late fall or early winter, at which time they partially decompose. Mallards decreased their consumption of agricultural grains during winter. Johnson grass and milo consumption peaked during December, and peak consumption of rice cutgrass occurred during January. This dietary shift may reflect increased food competition for agricultural grains. Black ducks consumed the greatest amount of spikerush in December and January and the greatest amount of agricultural grains during December and February. During late winter, waterfowl increase foraging rates and feed on energetically rich foods to obtain lipid reserves needed for spring migration (Paulus 1988). Black ducks and mallards at TNWR increased their energy consumption by consuming large amounts of carbohydrates (i.e., agricultural grains, spikerush, rice cutgrass, and Johnson grass) during late winter.

Despite minor differences in food habits between black ducks and mallards at TNWR, food habits of the species were very similar. This similarity could contribute to increased hybridization of black ducks and mallards because of overlap in foraging habitats. Managers should concentrate on differences in preferred foods of black ducks and mallards and attempt to minimize interspecific contact by separating preferred habitats. Such separation may be accomplished by flooding strips between adjacent black duck and mallard habitats, but additional research is needed to determine characteristics of such areas.

No significant differences were detected between diets of male and female black ducks or mallards wintering at TNWR during 1990-91. Jorde et al. (1983) found that food habits did not differ between sexes of mallards wintering in Nebraska, and Reinecke and Owen (1980) found similar proportions of invertebrates in male and female black ducks collected in Maine. Paulus (1988) suggested that nutrient requirements for nonbreeding male and female dabbling ducks are similar. Food habit data from this study indicate that nutrient and energy requirements for male and female black ducks wintering at TNWR also were similar.

Animal material was only a small component of mallard and black duck diets in this study. Animal foods contain a greater amount of protein but less energy and carbohydrates (i.e., NFE) than food consumed by ducks at TNWR (Krapu and Swanson 1975, Delnicki and Reinecke 1986). Feather replacement requires additional dietary protein (Heitmeyer 1985, 1988), but some studies have indicated that molting ducks can meet these needs without feeding upon invertebrates (Gruenhagen and Fredrickson 1990). Although a few ducks collected in this study were molting extensively (T. White, pers. comm.), they apparently met additional protein demands without increasing invertebrate consumption.

Reduced foraging time is one benefit of seed predominated diets. Amount of time allocated to feeding is dependent upon relationships among energy needs, nutrient requirements, and foraging strategies used in meeting those needs (King 1974). Birds selecting foods of low water and high carbohydrate content (e.g., agricultural grains) devote less time to feeding than those that feed upon less nutritional foods or foods which require searching (e.g., mobile invertebrates) or complex foraging behavior (e.g., underground tubers) (Rapport 1980). Black ducks at TNWR that feed mostly upon moist-soil seeds should have intermediate foraging time requirements (i.e., > grain predominated diets, but < invertebrate predominated diets).

During late winter, waterfowl increase foraging rates to obtain energy reserves needed for spring migration (Paulus 1988), and migrants may consume smaller proportions of invertebrates because of additional energy requirements (Gruenhagen and Fredrickson 1990). Because requirements for molting (i.e., high protein) and migration (i.e., high energy) are somewhat antagonistic, the balance between demands for protein and energy influence the relative importance of specific foods (Gruenhagen and Fredrickson 1990). Black ducks at TNWR feed primarily upon low protein foods, perhaps indicating that energy requirements for maintenance and spring migration are more important than protein demands. Following spring migration, protein demands of egg-laying probably supersede energy demands, as indicated by numerous studies of breeding ducks (Krapu 1974, Owen and Reinecke 1979, Drobney 1977, Serie and Swanson 1976); but energy appears to be the primary dietary demand of black ducks wintering at TNWR.

Energy requirements were reflected in food habits of ducks collected in this study. Foods high in carbohydrates and fats were primary foods consumed by black ducks and mallards wintering on TNWR during 1990-91. These foods provided energy for winter metabolism, thermoregulation, and locomotion between habitats during winter (Prince 1979). Plant seeds, however, may have been lacking in protein and minerals needed for body maintenance (Delnicki and Reinecke 1986); and black ducks and mallards may have consumed small quantities of invertebrates to fill these deficiencies. Data from this study suggest that the diet of black ducks and mallards at TNWR were sufficient to meet the energy and nutrient requirements of wintering in west central Tennessee.

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